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ARTICLE

An integrated craft and design approach for wearable orthoses

Peta Bush and Simone ten Hompel

The Sir John Cass School of Art, Architecture and Design, London Metropolitan University, London, UK

ABSTRACT

This article examines the design of orthoses, current approaches to their design are dominated by a biomedical approach that fails to address the biopsychosocial impact upon the wearer, often resulting in low adherence to the device. The case study, described in this paper, promotes a design-for-care ethos that incorporates co-design methods and craft sensibility to the design process. Patients become co-designers in a crafts-based workshop at the front-end of the design process. Using craft techniques, they share narratives regarding well-being and wearing orthoses. A hybrid approach was employed to analyse the data, which then informs and inspires the design process, and which identifies those design factors that affect the wearability of worn objects. The data analysis leads to the development of Therapeutic Jewellery; a hybrid object that sits at the intersection of medical science and contemporary jewellery, and is person-centric in its design and service. The project culminates with a body of work, including prototypes and finished artefacts, developed using traditional and digital technologies; and which has relevance for contemporary jewellery, design and healthcare.

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Co-design; design for care; therapeutic jewellery; contemporary jewellery; craft; person-centric

Introduction

This article examines the design and development of a wrist orthosis. The design research outlined in the paper is practice-based, and aims to advance knowledge by means of practice and through the outcomes of that practice. (Candy 2006). Whilst this has overlaps with action research, practice-based research can be further characterized as the embodiment of this knowledge within an artefact or series of artefacts; where the artefact becomes 'a researched proposition for changing reality' (Press, 1995).

The case study grew from the designer-researcher's own frustration towards wearing orthoses to support the management of Ehlers-Danlos Syndrome-hypermobility type, (EDS-ht)[1]. A contextual review identified current approaches

CONTACT Peta Bush bushp@staff.londonmet.ac.uk

to orthosis design are dominated by a biomedical approach that fails to fully address the biopsychosocial (BPS) impact upon the wearer, which leads to poor patient adherence towards these intimate objects. This is further exacerbated by service provision in the UK that does not provide the quality of service that patients require.

The paper continues by describing the research project undertaken to develop Therapeutic Jewellery as person-centric health devices – a new hybrid artefact situated at the intersection of wearable medical devices and contemporary jewellery. The research outlines current patient experiences towards wearing orthoses and the term person-centric is contextualized within personalized medicine. The design process is described by the case study of a co-design workshop with patients, where craft-based approaches are used to investigate people's experiences of illness and wearing orthoses. After analysing the data generated, the design and concept of therapeutic jewellery is developed, and culminates in a collection of therapeutic jewellery as wrist orthoses, which are evaluated by patients. Finally, future directions are contemplated that build upon this research.

Context

Orthoses[2] are defined as orthopaedic devices 'for the immobilization, restraint or support of the body' (Glanze, Anderson, and Anderson 1990). An important factor affecting their efficacy is the low rate of patient adherence towards their prescribed use. Paterson's (2013) review of literature identified that low patient adherence is explained by a number of reasons including: inappropriateness for the patient's condition; difficulty to remove and put on; issues with fit and comfort; hygiene; and undesirability. Further research described issues of style, aesthetics and cosmesis (McKee and Rivard 2011).

Orthosis design has not yet satisfactorily addressed these issues for patients, and there are few possibilities for personalization, with design choices reduced to a limited colour range. The research hypothesized that patient adherence towards orthoses could be improved if: (1) the design process was located within a contemporary jewellery framework that considered the biopsychosocial model of health (Engel 1977). (2) Patients were included in the design process.

A further issue for patient adherence is the poor orthosis service delivery in the UK. The Orthotics Campaign (2015) believes that the National Health Service (NHS) orthotics provision requires radical reform, and NHS England (2015) responded to their concerns with an action plan outlined in their report, recommending a new model of service that 'recognises that orthotic products are not commodities but individually prescribed solutions tailored to patient needs' (NHS England 2015).

The research culminated in a collection of Therapeutic Jewellery, demonstrating the potential of traditional and digital technologies, and including

prototypes and finished artefacts. Their description as *person-centric* acknowledges the terms *patient-centric* and *patient-centred* and highlights the importance of considering patients as people first, in a health system where patients often feel they have no voice (Ferguson 2007).

Whilst the terms *patient-centric* and *patient*-centred are often used interchangeably in the literature regarding personalized medicine, they also hold important differences pertinent to this research. Both terms promote patient involvement as central to the decision-making process, however whereas patient-centred can be described as a fixed state, patient-centricity is defined as an on-going process of patient involvement, that makes use of digital technologies (Robbins, Curro, and Fox 2013; Mulbacher 2015; Scher 2012).

Therefore, the researcher believes that *person-centric* best describes the proposed digital health project, which includes the opportunity for continual communication between patients and therapists using digital media. Finally, *person-centric* is employed in opposition to the term *body-centric* (used to describe technologies and other objects worn around and on the body), by promoting the importance of the wearer rather than the body upon which the object is located.

Design approach

A design-for-care approach argues that in order to deliver healthcare services and artefacts, the designer needs to adopt the mindset of professional care (Jones 2013). Adopting co-design methods is one way of fostering such an approach with the aim of increasing the empathic horizon[3] of the designer and other stakeholders. Here, the co-design event offers opportunities for listening to participants' experiences as one way of increasing empathy, and requires the designer-researcher to possess the narrative competence described by narrative medicine exponents as 'the ability to acknowledge, absorb, interpret, and act on the stories and plights of others' (Charon 2001). Furthermore, a co-design approach can move the focus away from a biomedical approach to a more holistic approach that explores all aspects of care towards the client (Flinn et al. 2013).

Contemporary jewellery is perceived as an appropriate medium to explore the design of these worn health objects, providing a framework in which to test existing notions of orthosis design. Jewellery has a long history of promoting the wearer's well-being, from amulets and talismans to the medic-alert jewellery of today. Indeed, Ramljak (2014) suggests it is jewellery's 'portability, tactility and close-proximity to the body that gives it a unique potency in regard to our wellbeing'.

Contemporary Jewellery is a practice and genre of jewellery dating from the 1950s that challenges aspects and characterizations of jewellery (Skinner 2013) and points to contemporary jewellers being well placed to engage in the design of wearable and personalized orthoses. Several jewellery designers have engaged with jewellery and health: from Mary-Ann Scherr, who in the 1970s,

designed heart monitor jewellery and cosmetic covers for tracheotomy patients and called them 'compassionate jewellery' (Scherr, 2001); to Jayne Wallace who worked on a project for dementia patients to fabricate a digital jewellery project that supported the personhood of the wearer (Wallace *et al*., 2013). A further jewellery designer is Leon Williams (2009), who designed medical jewellery, proposing that medical products needed to possess the jewellery qualities of desirability to improve user interaction (Williams 2009). One of the pieces he designed was an asthma inhaler that functioned as an object of adornment through the choice of materials and form. He characterized the term *medical jewellery* as an object worn on the body with medical function and with jewellery-like qualities. Therapeutic jewellery builds upon this definition by framing it within the biopsychosocial model, and by focusing on personalization.

Included in this concept of therapeutic jewellery is the notion that medical objects increase their wearability if they are seen as meaningful for the wearer. The search for meaning in acquired objects is characterized by 'complex combinations of products, services, spaces and information' (Brown 2009). Wearable medical devices have previously undertaken meaning change, with eyeglasses transformed from medical aids into fashion and style accessories (Pullin 2009). These are presently sold without prescription as style accessories, in opticians and also in high street fashion stores (Pullin 2009; Pithers 2015).

The meaning change for glasses supports the research hypothesis that orthoses can be transformed into desirable and styled objects. This is developed through the designer's focus upon creating meaning rather than functions or artefacts (Krippendorff and Butter 1993; 2007); and an engagement with strategies that change the symbolic content of objects and sensemaking (Verganti 2008; Battistella, Gianluca, and De Toni 2012). This and other aspects of the design process are explored in the following section.

Case study

The research proposed that a biopsychosocial health model should be employed for the design of therapeutic jewellery, to promote dimensions of the wearer's health that the biomedical model ignores, and to develop a more nuanced understanding of wearability for orthoses. This approach intended to examine methods that support design-for-care processes to improve the design and services of these artefacts.

The focus is upon a generative co-design workshop, situated at the fuzzy front-end[4] of the design process (Sanders and Stappers 2012). This was part of a project that included a scoping questionnaire; discussions on social media; and a sensitizing pack sent two weeks before the workshop (Table 1 summarizes the timeline). Its aim is to generate data that define the issues around the topic and inspire the design process. This approach is well suited to projects with limited resources; and where consistent input from participants is difficult to maintain

Table 1. Timeline of research project.

Activity	Scoping study	Sensitising pack	Workshop 2.5 hours	
Details	Questionnaire sent to 21 respondents + Social media discussions arising from responses.	Sent two weeks before workshop. Includes short daily tasks around the topic of orthoses.	Exercise A Collage box of health experience	Exercise B Model of health device of your dreams

over the duration of a design process. More specific objectives were: to investigate the potential to improve empathic horizons of designers and stakeholders; and to increase understanding around orthosis wearability.

Seven women with EDS-ht were recruited (with the support of the HMSA[5]), and participated in the 2.5 hour long workshop, which was women-only in order to create a safe environment to discuss sensitive issues around body issues, and to focus on solutions that incorporate themes of adornment for women. This research was seen as the opening trial for a series of studies positioned to research into patient experiences of wearing medical devices for a range of conditions and to explore patient involvement throughout the design process.

The data generated was analysed using qualitative analysis methods; this information was then used in the conceptualization phase to design wrist orthoses, culminating in a collection of therapeutic jewellery and the proposal of a digital health project.

Before the workshop, the participants were sent a sensitizing pack to allow them to explore the scope of the topic; to engage in designerly activities; to pose questions in creative and empathic ways; and for further information to be collected that could not be gathered within the workshop. The pack included a workbook with short daily tasks that included photographing objects and settings and describing aspects of their splint use (Figure 1).

The generative design workshop took place two weeks after the sensitizing packs are received. Generative design is a co-design method enabling people to make designerly artefacts and share stories about them (Sleeswijk Visser et al. 2005). For this purpose, two craft-based exercises were devised with the view that a craft approach allows for participants' ideas to be embodied in the process (Sullivan 2006); and that artistic forms of representation facilitate empathy (Leavy 2015).

Collage was chosen for the first exercise since it is a well-tried qualitative research technique, familiar with participants[6] and which enables the maker to communicate on a metaphorical level. It is also a powerful way for enabling people to think differently and producing connections that may be difficult to discuss. Whilst the thinking process, during making, provides a basis for the dialogues that began as they shared their stories with each other (Leavy 2015; Butler-Kisber and Poldma 2010).

Collage creation is recognized as a method that 'reproduces mental images and generates visual metaphors' (Pachler 2014; Rook 2006). Applying metaphor analysis also combines well with Charon's (2001) concept of narrative medicine

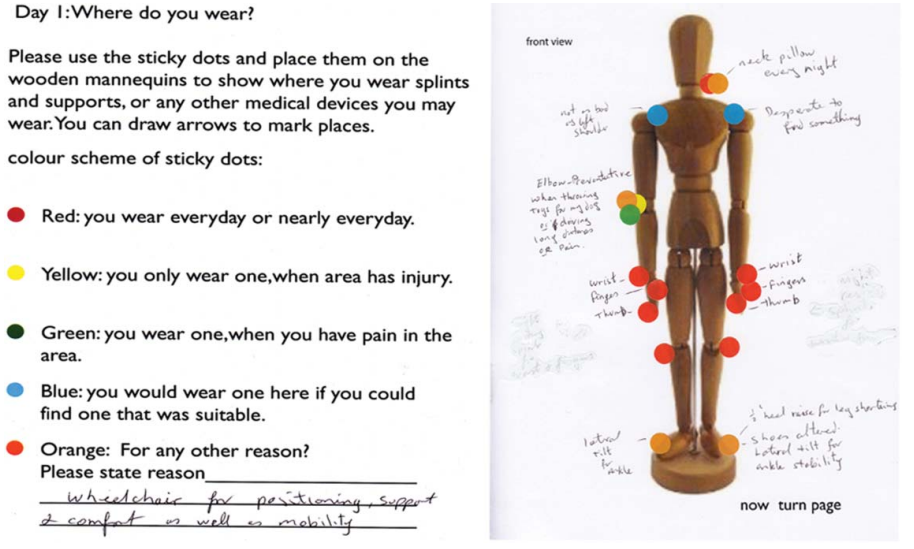

Figure 1. Example of workbook task: 'where do you wear?' showing one participant's responses with codes on right.

that considers metaphor and narrative as essential components of contemporary medicine.

Participants made an individual collage, on a cardboard box template (Figure 2) choosing from a collection of 100 images and 20 words, which described their

Figure 2. Workshop participant works on collage box exercise.

Figure 3. Collage box exercise showing example of EP's (a workshop participant) storyboard.

health and wellbeing experiences. On completion, they used these artefacts to share their personal health stories with the group, pointing out images that described meaningful events or feelings that they had experienced.

The cardboard box form was used to provide more creative possibilities, and embody their ideas in a three-dimensional (3D) form that could personify each maker. Some of the participants chose to storyboard their health experience with each box-face describing one important life event chronologically (Figure 3). Whereas some chose a snapshot approach that was not necessarily chronological, highlighting important factors or events. Finally, others chose to use the external box-faces to show their public self and the inner faces to show their private self or inner feelings.

On completion, each individual shared their experiences with the group, these generally included descriptions of: the onset of their illnesses; their experiences before diagnosis; the diagnosis itself; and their gradual acceptance of their health and changed lives.

The second exercise required participants to consider their 'dream wearable health device' and produce a model using the range of modelling materials provided (Figure 4). This enabled the exploration of orthosis solutions and accessed the participants' tacit knowledge regarding these objects. Participants were able to find ways to articulate dissatisfaction and explore ways of improving these objects. Again, after finishing their models, they shared their models and discussed how improvements could be made with the group.

The workshop generated a huge range of rich data and the following section describes its analysis.

Data collection and analysis

The data-generating methods used in this study enable the designer to tap into issues that can be difficult to access and to attend to the meaning-making in the

research process (Leavy 2015). However, the interpretation of generative design and craft-base data are emerging fields and, alongside the quantity of rich data, this makes the analysis process complex.

The data corpus included questionnaire responses; social media discussions; photographs; sensitizing pack workbook; collage boxes; models; audio-visual recordings; transcriptions and researcher's notes. A mixed approach was employed to analyse the rich and varied data, which borrows from several sources: grounded theory (Glaser and Strauss 1967); thematic analysis (Braun & Clarke 2006); visual analysis (Rose 2007); and metaphor analysis (Johnson 1990; Pachler 2014) and the process applied to data generated from the two exercises is now described,

Exercise A: collage box of well-being and illness experience

The participants' collage boxes and their stories of health generated data with the aim to increase the designer's empathic horizon (McDonagh-Philp and Denton 2000). Unexpectedly, it was recognized that the data also supported aesthetic decisions for the device designs, and that future co-design research could employ this technique to inform aesthetic design decisions.

The metaphors within the collages are analysed using the list of image schemata produced by Johnson (1990) who defines them as an 'imaginative structure of human understanding that influences the nature of meaning and constrains our rational inferences' (Johnson 1990). This research further uses Pachler's definitions of metaphor and image schema, where the term metaphor describes a 'verbal or visual expression of an image schema' (Pachler 2014); and where image schema 'denote a chief cognitive structure in the human mind that is fundamental to our understanding of what and how we perceive' (Pachler 2014; Zaltman 1997).

Frank's (1995) concept of three patient narratives is then considered for each participant's story. This was applied to provide additional understanding of each person's experience. The first of these narratives is the chaos narrative where a patient cannot verbalize her/his experience and is only able to speak of it retrospectively. The second is the quest narrative that offers the journey of illness and the individual's transformation; whilst the third is the restitution narrative can be defined as 'yesterday I was healthy, today I am sick, but tomorrow I'll be healthy again' (Frank 1995). An interesting aspect for the EDS-ht patient is that although they still have the same symptoms of disease, over time they may change the perception of their health and 'feel better' since they have explored psychosocial elements of the disease. The ensuing acceptance of their health as a positive notion also does not require the patient to feel she is giving up hope (Wendell 1996).

Table 2. EP's collage box-face 4 analysis.

EP collage box face 4 Metaphor analysis Metaphor	Image schemata	Meaning
1. Freedom	Container	Freedom
2. Hope	Space	Out of containment
3. Heart shape with red and orange pattern	Restraint removal	She can be hopeful
4. Create	Enablement	Heart is full, unbroken, Love
5. Group of 6 people	Container	Positive well-being
6. Hands holding out small box gift wrapped with ribbon	Enablement	New life
7. Smile	Links	Social
8. Peace	Transformation	New friends
9. Coloured textiles in pile- here shown on its side	Transformation	Life is a gift?
	Transformation	New life is a gift?
	Transformation	Acceptance is a gift?
	Enablement	Positive emotions
	Balance	Peace
		Colour, intensity
		Lively
Visual analysis		
Number of elements	9	All positive meanings
Use of area/distance of objects	Overlapping, with white border around	Balanced and integrated person
Composition	Freedom text at top with other images and texts overlapping below finishing with peace and colourful image. The texts appear more powerfully	Freedom is most important.
Verbal narrative		
…and now I've got hope create friends, new friends, my old friends everybody's gone, everybody's disappeared, as you said one friend lost you know lost everything. So I'm like just have to be happy to be sort of pacing along and if I do that everyday I'm quite happy and I've been really good for the last two-three years I mean I don't really have any days that I - I mean I don't cry any more, which is really a surprise because I think I spent five and half years crying, three years of counselling every week fighting, once I accepted it then you can move on.		
Comments: This fourth face concludes EP's health journey bringing us to the present time of the workshop. This is an optimistic collage that is full of colour and light and positive words.		

EP's collage box tells her health story from onset of symptoms up-to the date of the workshop. All the collage box-faces were analysed and Table 2 provides an example of the analysis of the final box-face of her story.

Whereas the first box-face showed her desperate and depressed as symptoms exacerbated and she feels the losses in her life, her thinking gradually changes until years later she is able to find acceptance. This long process is supported by the colour change in her collage from gloomy and sombre to the final two sides where she uses colour and images of nature to show how she feels. EP's story demonstrates Frank's (1995) restitution and quest narrative showing how a person with an incurable and chronic health issue discovers ways to make her life meaningful and find acceptance and well-being. The first two box-faces show Frank's chaos narrative with EP effectively communicating her sense of isolation and the chaos in her life.

Other participants used a mix of Frank's three narratives, whilst one participant used the chaos narrative throughout her story, and was unable to finish the collage box and her narrative since it was so upsetting for her. The telling of these stories in the workshop was a powerful event to witness and was compelling for the workshop facilitators.

The use of images became a powerful tool to communicate how they were feeling. One example is where EP shows the image of a woman's back, a broken chain and a sci-fi TV character (see Figure 3 collage box-face 2) and states:

> A good photo for me the back and that one on the top (points to sci-fi character) because its like my back has broken, that's how I visualise my illness - my back has broken. It's completely changed my life; I mean I'm a different person. I think in a different way.

The metaphor analysis made these made these images and spoken words richer in meaning. The process makes for a deep connection with each participant and, of all the data collected, it was these collage boxes that held most impact for the designer-researcher.

Exercise 2: health devices of your dreams

For this exercise, the co-designers were asked to design a model of the wearable health device of their dreams (Figure 4). The key aims of this exercise were to: (1) Generate data to inform the further design process. (2) Identify key themes and issues regarding orthoses. Their models, fabricated from a range of modelling materials, worked as prototypes – providing a way to visualize and contextualize experiences (Sanders and Stappers 2014; Stappers et al. 2009). The exercise allowed the co-designers to demonstrate their expertise of wearing orthoses and to offer solutions for their improvement.

EP designed a wrist splint (Figure 5) to be worn to a glamorous event; she used as little material as possible to create a light, breathable piece; and chose gold pipe cleaners since she wanted the real thing made in precious metals. She commented:

Figure 4. Left: CS's device uses minimum amount of material to support breathability, weight and skin tolerance. Also showing connecting back straps that work on posture (material: pipe-cleaners). Middle: Shows element of GS's shoulder support on left shoulder, with minimum amount of material (material: pipe-cleaners). Right: developing ideas by combining both devices.

Figure 5. Left: EP, workshop participant works on her model with facilitator. Right: finished model.

> To keep myself sane I like to go to one glamorous thing a week but you will never see me with 'a disabled-thing' on that evening…I think its about time people think about disabled stuff that is glamorous - nice to wear – 'designery'.

A second participant, AB, took a different approach commenting:

> I did a techno really futuristic jobby on this one… I wanted it to have buckles instead of Velcro, so I can take it off silently, 'cause I get really annoyed at night when my partner's asleep and I want to adjust it…Velcro noise.

This highlights the group's constant request for appropriate materials that fit into people's lives. She also incorporated speed dial buttons and energy capsules to talk quickly with loved ones and to call for transport, emphasizing the issues of isolation, travel and fatigue experienced by this group of patients.

The group's humour and orthosis design expertise, shone through in this exercise, their desire for individuality was apparent, and the models worked as conversational tools to present their ideas regarding the look, feel and function of these objects. Data was first categorized by the BPS model looking at the biomedical and then the psychological and social factors. Building on this, eight design actors were identified that influence wearability (Figure 6).

An important factor was fit, needed for the orthosis to function effectively. The poor fit and resulting discomfort, particularly experienced by women, frustrated participants. Style was perceived as important, with some individuals looking to fashion culture; for example, replacing a back orthosis with a corset possessing the same biomedical function (Williams 2016).

The co-designers criticized the poor choice of materials for orthoses, since many are made from neoprene that offers poor thermal comfort[7] along with reduced skin breathability and increased allergenic responses due to the large skin surface area covered. Comparing the materials performance of orthoses against those used in sportswear design, highlights the limited materials research that has been undertaken in the orthosis field.

The characteristics of emotional engagement and meaning of these objects are more intangible, with 'meaning' an elusive factor, and which can be best understood by considering the question 'does it fit into my world?' (Shedroff

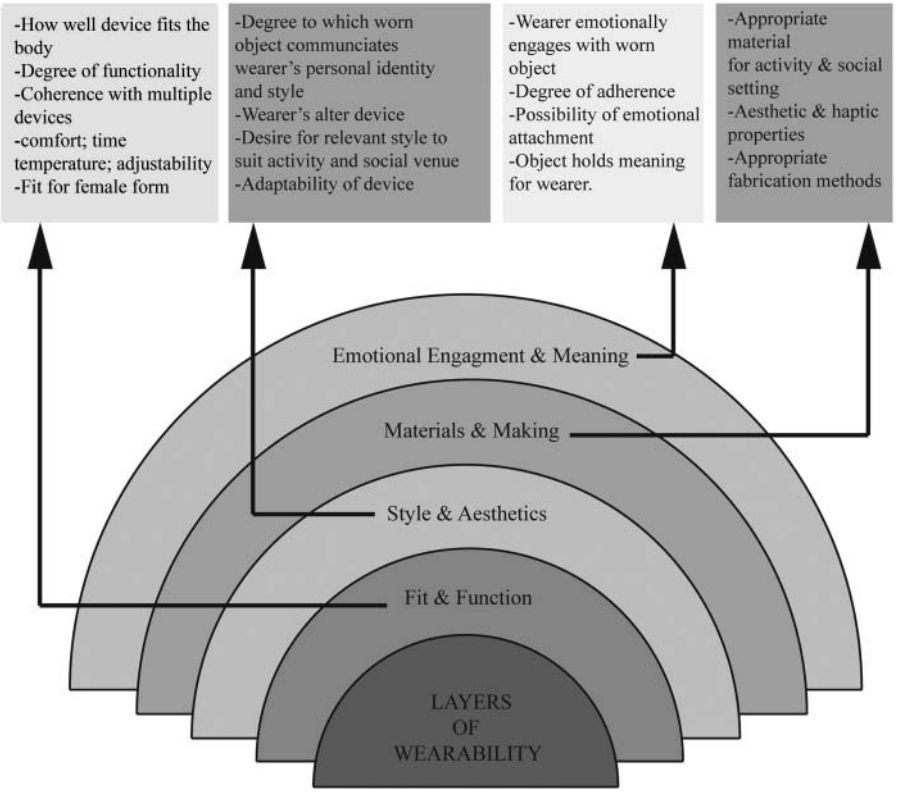

Figure 6. Layers of wearability – the design factors affecting patient adherence to wearing orthoses.

2006), and also 'do I understand how this helps me feel better?' As one respondent stated:

> I don't want to be defined and judged by 'granny beige' splints and surgical looking supports… I am a young woman who happens to have a disability - that's a side note. I also happen to have a very definite sense of style and that WILL translate to the very things that are meant to make my life easier and better, so help me!

In her response is the callout for orthoses to be concurrent in style with the wearer's clothes and accessories. In this respect, orthosis design needs to incorporate the understanding that wearable objects have an important role in the construction and maintenance of identity. Exploring concepts of jewellery and style, therefore, offer great potential in delivering these aspects of wearability for orthoses and other wearable medical devices. (Farringdon, 2016; Cohn 2009).

The analysis of the patient narratives further supported the development of what Charon (2001) describes as 'narrative knowledge', which is employed 'to understand the meaning and significance of stories through cognitive, symbolic and affective means'. Whilst she sees it as important to the patient-doctor

relationship, it can be seen as equally relevant for developing empathic relations within the patient-designer relationship

Conceptualization phase

The project develops the role of e-patient towards that of D-patient, defined as someone who 'engages in their own medical care using their own creativity and maker skills' (Prescribe Design 2015). The research insights generated a series of relevant themes, and here the designer responds to that understanding with new artefacts.

The design of a wrist orthosis was approached in a reflective and emergent manner that explored their design through drawings, models and an online digital resource of contextual images[8]. As a springboard, a collage was created with the images and words most used by the participants. The image of the gift motivated the maker to consider how orthoses could be perceived as gifts (similar to jewellery). A further theme was the use of nature imagery to describe their health positively. The concept of *freedom* and the opportunity to make choices were seen as important, and this also suggested the need for a range of orthoses. Two of the popular images used were the Amazon Warrior and Wonder Woman, along with the frequent use of the word *strength,* and these seemed in direct opposition to the feelings of disempowerment that participants experienced. The designer used these themes playfully to inspire design concepts that might be worn by these two archetypes in the twenty-first century.

A series of models were made using different materials to explore characteristics that include: form; construction; weight; skin coverage; flexibility; meaning and emotional attachment (Figure 7). These models worked at signalling how to

Figure 7. Left: collection of the models in wood, plastic, paper, to develop 'Fresh Embrace' – one of the pieces. Middle and right: development of 'Minimum' using pipe cleaners and electric cable models.

Figure 8. Left: 'Fresh Embrace' in PLA. Right: 'Composed Clasp' in PLA with changeable insert.

work with the body and the design elements whilst considering how the artefact can best signal a wearer's identity and culture. They supported a developing dialogue with other designers, where issues raised by co-designers were considered and developed.

Four collections were created, designed for the designer's wrist, to demonstrate the technologies available to design these devices, and that embody concepts developed from the workshop. There are two 3D printed collections created from 3D scans of the wrist and then taken into a CAD programme (Rhino). The first is printed on a desktop 3D printer, to examine the possibilities of designing on domestically available machines (see Figure 8), whilst the second collection (Figure 9) explores the possibilities of using SLS machines.

They both explore the use of digital technologies to produce a variety of design choices for the wearer[9]. The third collection (Figure 10) is designed using traditional craft techniques through collaborations with a silversmith, jewellery designer-maker and cabinet-maker. Pieces were fabricated using silver and reclaimed hardwoods (Figure 10). They explore the use of silver and wood traditionally used in jewellery, to explore notions of jewellery qualities.

The final collection uses felt to show the possibilities of using traditional textiles and the potential of using advanced materials in their fabrication (Figure 11).

Figure 9. Left: 'Minimum' orthosis worn with one of the 'Maximum' accessories in black nylon. Right: 'Minimum' orthosis shown with full range of 'Maximum' accessories available, in black nylon; top row: 'Minimum' orthosis; bottom row: 'Maximum' accessories available to wear with 'Minimum'.

Figure 10. Left: 'Minimum' in silver, bench fabricated. Middle: 'Hand Sandal' in reclaimed oak and leather, bench fabricated. Right: 'Graceful Hug' in silver and reclaimed oak.

A further aspect identified by the research was the poor orthotic service provision in the UK. (Orthotics Campaign 2015; NHS England, 2015). Whilst the project identified that 3D printing could play a valuable role in increasing choice and decreasing waiting times, it was posited that a digital web-based service was required to enable patients to choose personalized artefacts that were either open source or available to buy. This raises the issue of whether similar to the 'IKEA effect' (Anderson 2012), where people tend to value more highly those products in which they have contributed, that patients would also feel a higher degree of adherence if they were able to make decisions about the designs of their orthoses. Moreover, it would promote a person-centric service that provides on-going support for the patient and ensures that the patient understands how to use the device over its lifespan.

Responses, to the collections and digital project, from participants are overwhelmingly positive, with one commenting:

> Having some sort of control over the devices, choices, supports etc. that help improve my quality of living daily gives me back a sense of self and sense of respect and, if people have that, they are less likely to become depressed and spiral downwards physically and mentally.

The need for person-centric devices was reflected by feedback that supported patients' desire for orthoses that incorporate all notions of wearability.

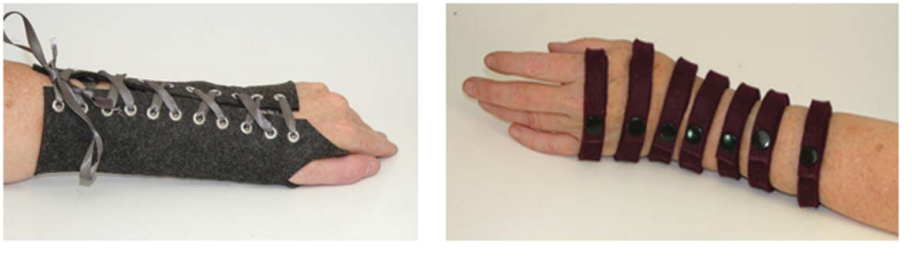

Figure 11. Left: 'Wrist Corset' in grey felt and ribbon. Right: 'Felt Lines' in aubergine felt with black poppers.

Conclusion

The positioning of orthosis design within a contemporary jewellery practice allows the focus to be extended beyond the medical body and to embrace psychosocial aspects. This challenges the notion of wearability and expanded it beyond body location to encompass the eight layers of wearability that include the concepts of emotional engagement and meaning. The research promoted a mix of craft, design and data analysis approaches that developed an empathic understanding of co-designers' experiences around well-being. In addition, it identified wearability factors that affect patient adherence towards these devices.

By challenging the meanings of orthoses, a new hybrid artefact called therapeutic jewellery is developed. This provides a biopsychosocial response to making person-centric devices, which is further supported by the proposal of a digital web-based service with on-going support to those using these services. Therapeutic jewellery functions as a crafted object to construct meaning and to offer dignity and grace to people's lives (Metcalf 2002). Accordingly, it builds upon a relationship between orthoses and craft where anatomical and material knowledge is expressed. Future directions offer further development of the co-design processes and testing them with patient groups and other wearable medical devices. Whilst material research is crucial if these devices are to become truly wearable, the potential of 3D technologies are also pointing to the fabrication of person-centric devices and services.

Transdisciplinary teams including healthcare professionals, craftspeople and patients offer great scope for future research. Including patients in the co-design process is seen as a necessary evolution for the design of wearable orthoses; and should also point to greater potential for continual communication between patients and healthcare professionals whilst the device is being worn. Finally, it is hoped that a design for care ethos will lead to designing for people rather than for a collection of symptoms.

Notes

1. A chronic multi-systemic health condition that causes a variety of symptoms including chronic pain, joint dislocations and injuries. Orthoses are often prescribed over a the EDS patient's lifetime to support the management of the debilitating symptoms of EDS-ht; and are generally prescribed alongside physiotherapy regimes and pain management courses.
2. Other words used interchangeably are: splints, braces and supports.
3. The term empathic horizon is used to indicate the range of an individual's ability to empathize for others in different contexts (McDonagh and Denton 2000).
4. First coined by Reinertsen and Smith (1991), fuzzy front-end describes the beginning design process where strategy and direction are devised.
5. HMSA: Hypermobility Syndromes Association.
6. This is a popular art activity in UK schools.

7. Thermal comfort is defined as the degree of 'physiological, psychological and physical harmony between human body and the environment' (Öner and Okur 2014).
8. The designer-researcher used Pinterest a social media image collection.
9. 3D printing offers the possibility of offering different materials for these devices, as well as an excellent fit.

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Notes on contributors

Peta Bush is a designer-researcher currently studying for a PhD at The Cass. Her work researches into design for care and wearable health devices as person-centric health artefacts.

Simone ten Hompel is a reader at The Cass. She is a practising metalworker who contributes to exhibitions around the world and speaks about craft and making.

ORCID

Peta Bush http://orcid.org/0000-0002-5600-046X

References

Anderson, C. 2012. *Makers: The New Industrial Revolution*. New York: Crown Business.

Battistella, C., B. Gianluca, and A.F. De Toni. 2012. "From Design Driven Innovation to Meaning Strategy." *Management Decision* 50 (4): 718–743.

Braun, V., and V. Clarke. 2006. "Using thematic analysis in psychology." *Qualitative research in psychology* 3 (2): 77–101.

Brown, T. 2009. *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. New York: Harper Business.

Butler-Kisber, L., and T. Poldma. 2010. "The Power of Visual Approaches in Qualitative Inquiry: The Use of Collage Making and Concept Mapping in Experiential Research." *Journal of Research Practice* 6 (2): M18.

Candy, L. 2006. "Practice Based Research: A Guide." *CCS Report* 1: 1–19.

Charon, R. 2001. "Narrative Medicine: A Model for Empathy, Reflection, Profession and Trust." *JAMA* 286 (15): 1897–1902.

Cohn, S. 2009. "Recoding Jewellery: Identity, Body, Survival." PhD thesis. University of NSW.

Engel, G.L. 1977. "The Need for a New Medical Model: A Challenge for Biomedicine." *Science* 196 (4286): 129–136.

Farringdon, C. 2016. "Wearable Technologies and Stigma in Diabetes: The Role of Medical Aesthetics." *The Lancet: Diabetes & Endocrinology*. Accessed 30 October 2016. http://www.thelancet.com/journals/landia/article/PIIS2213-8587(16)00075-9/abstract.

Ferguson, T. 2007. "E-Patients: How They Can Help us Heal Healthcare." In *Patient Advocacy for Health Care Quality: Strategies for Achieving Patient-Centered Care*, edited by J. A. L. Erp, E. A. French, and M. B. Gilkey, 93–150. Sudbury, MA: Jones and Bartlett Publishers.

Flinn, S.R., E.B.-N. Sanders, W.-T. Yen, C.M. Sommerich, and S.A. Lavender. 2013. "Empowering Elderly Women with Osteoarthritis Through Hands-On Exploration of adaptive Equipment Concepts." *Occupational Therapy International* 20 (4): 163–172.

Frank, A.W. 1995. *The Wounded Storyteller: Body, Illness, and Ethics*. Chicago: The University of Chicago Press

Glanze, W.D., K. Anderson, and L.E. Anderson. 1990. *Mosby's Medical, Nursing, and Allied Health Dictionary*. St Louis, MO: Mosby.

Glaser, B., and A. Strauss. 1967. *The discovery of grounded theory*. London: Weidenfield & Nicolson.

Johnson, M. 1990. *The Body in the Mind*. Chicago: University of Chicago Press.

Jones, P. 2013. *Design for Care: Innovating Healthcare Experience*. New York: Rosenfeld Media.

Krippendorff, K., and R. Butter. 1993. "Where Meanings Escape Functions." *Design Management Journal (Former Series)* 4 (2): 30–37.

Krippendorff, K., and R. Butter. 2007. "Semantics: Meanings and Contexts of Artefacts." In *Product Experience*, edited by H.N.J. Schifferstein, and P. Hekkert, New York: Elsevier. Accessed 15 November 2016. http://repository.upenn.edu/cgi/viewcontent.cgi?article=1090&context=asc_papers

Leavy, P. 2015. *Method Meets Art: Arts-Based Research Practice*. Guilford: Guilford Publications.

McDonagh-Philp, D., and H.G. Denton. 2000. "User-Centred Design and The Focus Group: Developing The Student Designer's Empathic Horizons." In: *Design and Technology International Millennium Conference*. edited by R. Kimbell, 111–116. Wellesbourne: The D&T Association.

McKee, P.R., and A. Rivard. 2011. "Biopsychosocial Approach to Orthotic Intervention." *Journal of Hand Therapy: Official Journal of the American Society of Hand Therapists* 24 (2): 155–162.

Metcalf, B. 2002. "Contemporary Craft: A Brief Overview." In *Exploring Contemporary Craft*, edited by J. Johnson. Toronto: Coach House Books & Harbourfront Center.

Mühlbacher, A.C. 2015. "Patient-Centric HTA: Different Stokes for Different Folks." *Expert Review of Pharmacoeconomics & Outcomes Research* 15 (4): 591–597.

NHS England. (2015). *Improving the Quality of Orthotics Services in England*. NHS England Publications.

Öner, E., and A. Okur. 2014. "Thermophysiological Comfort Properties of Selected Knitted Fabrics and Design of T-Shirts." *The Journal of The Textile Institute* 106 (12): 1403–1414.

Orthotics Campaign. 2015. *About the Campaign*. [Online]. Accessed 2 September 2016. http://www.orthoticscampaign.org.uk/about.html.

Pachler, P. 2014. *How Collages Reveal Your Deepest Thoughts: A Guide to Consumers' Minds*. Hamburg: Anchor Academic Publishing.

Paterson, A.M. 2013. *Digitisation of The Splinting Process: Exploration and Evaluation of a Computer Aided Design Approach to Support Additive Manufacture*. Doctoral thesis, Loughborough University.

Pither, E. 2015. "When did Glasses Become Cool?" *The Telegraph*, May 27. http://www.telegraph.co.uk/fashion/style/when-did-glasses-become-cool/.

Prescribe Design. 2015. "D-Patients: Patients Who Design." Accessed 14 November 2016. http://prescribedesign.com.

Press, M. 1995. "Its Research Jim." Paper presented at The European Academy of Design, Inaugural Conference, Design Interfaces, University of Salford, April 11–13.

Pullin, G. 2009. *Design Meets Disability*. Cambridge, MA: MIT press.

Ramljak, S. 2014. *On Body and Soul: Contemporary Armor to Amulets*. Atglen, PA: Schiffer.

Reinertsen, D. G., and P. G. Smith. 1991. "The strategist's role in shortening product development." *Journal of Business Strategy* 12 (4): 18–22.

Robbins, D.A., F.A. Curro, and C.H. Fox. 2013. "Defining Patient-Centricity Opportunities, Challenges, and Implications for Clinical Care and Research." *Therapeutic Innovation & Regulatory Science* 47 (3): 349–355.

Rook, D.W. 2006. "Let's Pretend: Projective Methods Reconsidered." In *Handbook of Qualitative Research Methods in Marketing*, edited by Wlk. Russell, 143–155. Cheltenham: Edward Elgar.

Rose, G. 2007. *Visual Methodologies: An Introduction to Researching with Visual Materials*. London: Sage.

Sanders, E.B.N., and P.J. Stappers. 2012. *Convivial Toolbox: Generative Research for the Front End of Design*. Amsterdam: BIS.

Sanders, E.B.N., and P.J. Stappers. 2014. "Probes, Toolkits and Prototypes: Three Approaches to Making in Codesigning." *CoDesign* 10 (1): 5–14.

Scher, D.L. 2012. *How Patient-Centric Care Differs from Patient-Centered Care*. The Digital Health Corner. Accessed 6 January 2016. http://davidleescher.com/2012/03/03/how-patient-centric-care-differs-from-patient-centered-care-2/.

Scherr, M.J. 2001. "Oral History Interview with Mary Ann Scherr, 2001 April 6-7." *Archives of American Art, Smithsonian Institution*. Accessed 28 April 2016. http://www.aaa.si.edu/collections/interviews/oral-history-interview-mary-ann-scherr-12648.

Shedroff, N. 2006. *The 15 Core Meanings*. [Online]. Accessed 3 September 2016. http://nathan.com/making-meaning/.

Skinner, D. ed. 2013. *Contemporary Jewelry in Perspective*. New York: Lark Jewelry & Beading.

Sleeswijk Visser, F., P.J. Stappers, R. Van der Lugt, and E.B. Sanders. 2005. "Contextmapping: Experiences from Practice." *CoDesign* 1 (2): 119–149.

Stappers, P. J., H. van Rijn, S. C. Kistemaker, A. E. Hennink, and F. S. Visser. 2009. "Designing for other people's strengths and motivations: Three cases using context, visions, and experiential prototypes." *Advanced Engineering Informatics* 23 (2): 174–183.

Sullivan, G. 2006. "Artefacts as Evidence Within Changing Contexts." *Working Papers in Art and Design* 4: 1466–49.

Verganti, R. 2008. "Design, Meanings and Radical Innovation: A Meta-Model and a Research Agenda." *Journal of Product Innovation Management* 25 (5): 436–456.

Wallace, J., P. C. Wright, J. McCarthy, D. P. Green, J. Thomas, and P. Olivier. 2013. "A Design-led Inquiry into Personhood." In *CHI 2013 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 2617–2626. New York, NY: ACM.

Wendell, S. 1996. *The Rejected Body: Feminist Philosophical Reflections on Disability*. London: Routledge.

Williams, L. 2009. "The Development of Digital Technologies for Use in Jewellery with Medical Applications." PhD diss., Royal College of Art.

Williams, L. 2016. *Solaced: 101 Uplifting Narratives About Corsets, Wellbeing and Hope*. Middlow Publishing.

Yair, K., and M. Schwarz. 2011. "Making Value: Craft in Changing Times." *Cultural Trends* 20 (3–4): 309–316.

Zaltman, G. 1997. "Rethinking Market Research: Putting People Back." *Journal of Marketing research*. XXXIV (Nov.): 424–437.